Segmented Mirrors for Constellation-X
Status and Plans for FY 2000

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Goals for remainder of FY 2000

* Demonstrate geometry-limited resolution for conical reflector pair
  * Replicate reflectors using glass substrates and ROSI mandrels
  * X-ray performance test to determine blur contribution of substrate
* Replicate axially curved surfaces (6 cm mandrel)
  * Demonstrate applicability of approach to Wolter geometry
* Demonstrate performance of Si microcombs in breadboard fixture
  * Allow more accurate determination of alignment error term
  * Facilitate design of prototype housing
* Production and replication of 0.5 m segments
  * Produce large glass segments
  * Use formed Be to demonstrate feasibility of replication

Segmented Mirror Development

Keys to meeting 15” angular resolution goal

* Mandrels - microscopically smooth, with accurate figure

* Substrate - free standing reflectors with high fidelity to optical design

* Housings - accurately align reflectors introducing minimal distortion

Research supplemented by development of metrology and analysis tools

Segmented Mirror Development

Mandrels

* Need for accurately figured Wolter mandrels is common to segmented and shell approaches (but segmented approach does not require full shells)

* MSFC Ni/Al mandrel (0.2 m)
  - demonstrated GSFC can accurately replicate foils from metal mandrel
  - best global figure ever produced on a foil reflector (<12")
  - repolishing has yielded ~3 Å microroughness (twice); will be passivated at GSFC
* Series of 0.2 m Ni/Al mandrels being produced by GSFC Optics Branch
  - cylinder, conical secondary, paraboloid, hyperboloid
  - in house diamond turning, polishing capability should facilitate rapid turnaround
* Axially curved (Wolter I) 6 cm mandrel
  - to be used for first replication of curved surface (50Å microroughness)
  - delivered from MSFC on 1/20/00; forming mandrel in house
* Two 0.2 m quartz mandrels (still) on order from ROSI
* 50 cm mandrels available at MSFC for replication

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Substrates

* Thermally formed glass has become our baseline
  - Replication facilitates ability to sacrifice microsurface for 2D figure
  - Forming over convex mandrel
  - Forming process continually being improved; edge effects minimized
  - Have developed accurate (<25µm) edge cutting process
  - Get very accurate substrates - <7" figure errors

* Have established formed Be as viable backup
  - 30 degree P/H pair (50 cm dia) has been delivered and awaits replication; 2nd pair on order
  - Surface accurate to within ~25µm

* Work continues on metallic substrates
  - 300 µm Al alloy shows much better performance than 200µm ASTRO-E material

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Housings/Alignment

* Structure and assembly concept and analysis continue at SAO
  - Flight units contain no precision structures
  - Precision alignment depends exclusively upon Si microcombs
* Significant progress in establishing Si alignment bar production process
  - Alignment bar production process nearly mature
  - Metrology of prototype alignment bars yields accuracy of =2.5 µm
* Si alignment bar test housing nearly complete
  - Will allow measurement of alignment accuracy
  - Will allow comparison of Si bar mechanical properties with expectations

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Infrastructure/Metrology

* Developing in-house capability for producing small Al/Ni mandrels
  - Relies on Optics Branch diamond turning lathe
  - Computer controlled polishing being set up
  - Hand polishing has yielded ~3Å rms surfaces (MSFC mandrel)
  - Have set up facility to perform Ni surface passivation (using MSFC recipe)

* Full suite of metrological tools and techniques being developed
  - Surface PSD and figure measurement using Bauer and WYKO
  - Global figure measurement using computer generated holograms

* Full suite of analysis software
  - Utilizes OSAC plus specially written software

Segmented Mirrors for Constellation-X

Issues / Concerns

* Mandrels
  * Raytheon mandrels are more tha one year late; may not arrive until June
  * Currently do not have mandrel pair (cones or Wolter)
  * Group of mandrels for multiple reflector prototype will be costly (and long lead)

* Housings
  * Accurate adjustable mount for testing reflector pairs not yet available
  * Progress toward demonstration of Si-based alignment scheme has been slower than hoped

* =0.5 m segment fabrication
  * Long lead, high priced items necessary for production (e.g., $100k oven)
  * Logistical issues associated with attempting replication (at MSFC or GSFC)